SPUTTERING SYSTEM

Patent number: JP2001348663
Publication date: 2001-12-18
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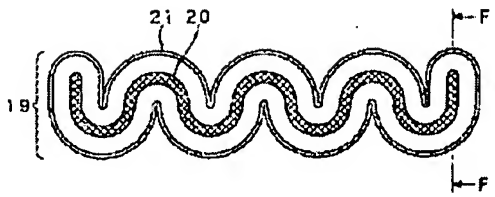
Classification:
- international: ***C23C14/35;*** **C23C14/35**; (IPC1-7): C23C14/35
- european:
Application number: JP20000172614 20000608
Priority number(s): JP20000172614 20000608

Abstract of **JP2001348663**
PROBLEM TO BE SOLVED: To improve the utilizing efficiency of a target, the sputtering rate and the precision of film deposition thickness in a sputtering system. SOLUTION: A magnetic circuit 19 is provided with an internal magnet 20 having a meandering shape and external magnets 21 arranged at prescribed intervals around the internal magnet 20. In this way, the magnetic circuit 19 binds electrons by magnetic flux 23 formed by the internal magnet 20 and the external magnets 21, and an erosion region 25 appearing on the surface of a target 17 is made into closed curves while being meandering, by which curved parts 100 are remarkably increased compared to the case in the conventional erosion region 99.



JP 2001-348663 A (English translation)

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention belongs to the technical field of a sputtering system, and relates to a sputtering system equipped with especially a magnetic circuit.
[0002]
[Description of the Prior Art] a spatter -- a vacuum deposition method and CVD (Chemical Vapour Deposition) -- it is the thin film coating technology widely applied to creation of the reflective film of optical record media including law, a list, and an optical disk, and the protective coat of magnetic-recording media, such as a magnetic tape, etc. After devising especially the magnetron sputtering method, a membrane formation rate improves and the effectiveness is increasing increasingly.
[0003] The process of a general spatter is shown below. Discharge gas, such as Ar, is introduced in the chamber of the vacuum currently first exhausted to 10-7Torr extent with various vacuum pumps, and the pressure in a chamber is maintained at 10-3Torr extent. The chamber is grounded at this time. And the discharge gas in a chamber is plasma-ized and the ion of discharge gas charged in plus collides with a target. Of this collision, the component of a target is calculated from a target and the thin film according to the construction material of a target is formed in a spatter-ed material front face by adhering to a target on the spatter-ed material front face by which opposite arrangement was carried out.
[0004] In a spatter, electric field are formed on a target front face of the cathode drop in near a target, and the sense of the line of electric force becomes vertical to a target. In addition, by the magnetron sputtering method which is a spatter with a magnetic circuit, a magnetic field is formed on a target front face by arranging a magnetic circuit at the target rear face. The secondary electron which is an electron calculated with the component of a target to a target at the time of a spatter performs cycloid motion in response to a Lorentz force under the effect of the electric field and the magnetic field which were generated on this target front face. Consequently, between target surface absentminded, many electrons which have high energy are restrained and the high density plasma is generated in this space. Therefore, the magnetron sputtering method can generate the high density plasma, even if discharge gas pressure is low.
[0005] As mentioned above, since the magnetron sputtering method can generate the high density plasma also with comparatively low discharge gas pressure, it can reach spatter-ed material, without the atom and molecule by which the spatter was carried out receiving dispersion by the discharge gas atom from a target. Therefore, the magnetron sputtering method is a spatter with the effectiveness of raising a sputtering rate.
[0006] By the way, when it reaches far and wide comparatively and forms a thin film by the magnetron sputtering method like [in the case of forming a protective coat] on a magnetic tape, the rectangle plate target which is a target of a rectangle configuration is used.
[0007] The cathode in the conventional sputtering system equipped with such a rectangle plate target is equipped with a target 92, the back up plate 93, and a magnetic circuit 110 as shown in drawing 9 **** drawing 11 . this magnetic circuit 110 -- an inner magnet -- 94 and an outer magnet -- it is constituted by 95 and the yoke 96. In addition, the following explanation explains only near the cathode in the magnetron sputtering method as shown, conventional important section, i.e., drawing 9 **** drawing 11 , of a sputtering system. Here, drawing 9 is the outline perspective view of a cathode. Next, drawing 10 is the outline sectional view of the cathode in which a magnetic circuit 110 is shown, and is an outline sectional view in the A-A line shown in drawing 11 . And drawing 11 is an outline sectional view in the B-B line shown in drawing 10 .
[0008] A target 92 is usually pasted up on the back up plate 93, as shown in drawing 9 . And a negative electrical potential difference is impressed to this back up plate 93. the inner magnet

which is in the center section of the magnetic circuit 110 as a magnetic circuit 110 is shown in drawing 10 -- it arranges around 94 and this inner magnet 94 -- having -- an inner magnet -- the outer magnet which has the magnetic polarity of reverse to 94 -- it is constituted by 95 and the yoke 96. moreover, the yoke 96 arranged to a target 92 at the rear-face side as a magnetic circuit 110 is shown in drawing 11 -- an inner magnet -- 94 and an outer magnet -- 95 is connected magnetically. And on target 92 front face, the magnetic field which carried out the tunnel-like configuration where the line of magnetic force 97 formed in the shape of a semicircle of this magnetic circuit 110 stood in a row is formed. Then, the high density plasma 91 is restricted on the front face of a target 92.

[0009] Thereby, the erosion field 99 is formed as a configuration of the closed contour which had predetermined width of face in the front face of the target 92 in just under the high density plasma 91, as shown in drawing 12 . This erosion field 99 consists of the curvilinear section 100 which consists of curves, and a bay 101 which consists of straight lines.

[0010] In addition, the conventional sputtering system may presuppose that it has two or more magnetic circuits 110 as shown in drawing 9 **** drawing 11 , as drawing 13 **** drawing 15 shows. Here, in drawing 13 **** drawing 16 , since it is the sputtering system and **** EQC which the configuration of each part mentioned above, the same sign as drawing 9 **** drawing 12 is attached, and explanation is omitted.

[0011] The magnetic circuit 130 with the two above-mentioned magnetic circuits 110 is what has arranged the magnetic circuit 110 to juxtaposition, as shown in drawing 14 . In this case, it has predetermined width of face in the front face of a target 92, and the erosion field 102 is formed as a configuration of two closed contours where it became independent, as shown in drawing 16 . For this reason, generally the cathode equipped with a magnetic circuit 130 is called the double erosion cathode. On the other hand, as for one cathode, the erosion field 99 is called the single erosion cathode like the example mentioned above.

[0012]

[Problem(s) to be Solved by the Invention] In the conventional sputtering system, the erosion field 99 is formed as a closed contour which had predetermined width of face along the level magnetic field of the line of magnetic force which a magnetic circuit 110 forms, as shown in drawing 12 .

[0013] Moreover, in the conventional sputtering system, the erosion field 99 in the front face of a target 92 will be restricted to a part to the whole surface of a target 92, and a bias will be made in spatter effectiveness in the erosion field 99. A bias appears in thickness distribution of the thin film formed in spatter-ed material by this, and also the point of reducing the utilization effectiveness of a target 92 has been a technical problem.

[0014] Then, this invention aims at offering the sputtering system which improves the utilization effectiveness of a target with improvement in spatter effectiveness and a sputtering rate by solving the conventional technical problem mentioned above and devising arrangement of a magnetic circuit.

[0015]

[Means for Solving the Problem] In order to attain the object mentioned above, as a result of this invention person's inquiring wholeheartedly, in the bay and the curvilinear section of an erosion field, spatter effectiveness differs and the more nearly curvilinear section came to acquire the knowledge that spatter effectiveness becomes high. Furthermore, it came to acquire the knowledge that a sputtering rate improves, so that the total extension of the closed contour of an erosion field became long. Then, the sputtering system concerning this invention is made [improving the utilization effectiveness of a target, and] possible by devising arrangement of the magnetic circuit on the rear face of a target based on this knowledge.

[0016] That is, the sputtering system concerning this invention is equipped with the back up plate which is connected to a power source and has a function as a cathode electrode, the

target adhered to a back-up-plate front face, and the magnetic circuit which counters a target and is arranged at the back-up-plate rear face. This magnetic circuit is arranged so that it may become the closed contour closed the erosion field which appears on the surface of a target lying in a zigzag line.

[0017] With the line of magnetic force which a magnetic circuit forms, by considering as the closed contour closed moving the erosion field which appears in a target front face in a zigzag direction, the sputtering system concerning this invention constituted as mentioned above can increase the curvilinear section, and can make a secondary electron's existence probability high over between [whole] target surface absentminded.

[0018]

[Embodiment of the Invention] Hereafter, the gestalt of operation of the sputtering system concerning this invention is explained to a detail, referring to a drawing. In addition, below, the example of 1 configuration which applied the sputtering system concerning this invention is given.

[0019] The sputtering system which applied this invention is constituted by the chamber 10, the power source 11, and the decompression device 12 as shown in drawing 1 .

[0020] The chamber 10 equips the chamber 10 interior with a cathode 13, the spatter-ed material 14, and a supporter 15. Here, a chamber 10 is decompressed with a decompression device 12, for example, various vacuum pumps. Moreover, discharge gas 16 is injected into a chamber 10 to the chamber 10 interior after reduced pressure, and it has structure which keeps the pressure in a chamber 10 constant. This discharge gas 16 is for example, Ar gas. The chamber 10 is grounded at this time.

[0021] The cathode 13 is constituted by non-magnetic material 17, for example, the target constituted by graphite, the back up plate 18, and the magnetic circuit 19. Here, a target 17 is pasted up on back-up-plate 18 front face, and the magnetic circuit 19 is installed so that back-up-plate 18 rear face may be countered with a target 17. A power source 11 impresses a negative electrical potential difference to the back up plate 18 while it connects with a supporter 15 and the back up plate 18 and it impresses a forward electrical potential difference to a supporter 15. Thereby, especially between the back up plate 18 and a supporter 15, electric field are generated by the cathode drop on back-up-plate 18 front face. And the sense of the line of electric force of this electric field becomes vertical to a target 17.

[0022] a magnetic circuit 19 -- an inner magnet -- 20 and an outer magnet -- it is constituted by 21 and the yoke 22, and to the back up plate 18 and a target 17, the spatter-ed material 14 counters the field of an opposite hand, and is arranged. In outer magnet 21, the yoke 22 connects magnetically as inner magnet 20. here -- an inner magnet -- 20 is arranged in the center of a magnetic circuit 19 -- having -- an outer magnet -- 21 -- an inner magnet -- it arranges so that 20 may be surrounded at the predetermined spacing -- having -- an inner magnet -- 20 and an outer magnet -- 21 is the magnetic polarity of reverse mutually. The magnetic field formed of this magnetic circuit 19 is shown by the line of magnetic force 23 of the shape of a semicircle on target 17 front face, and the high density plasma 24 restricted by electric field and the magnetic field exists so that it may be shut up by this line of magnetic force 23.

[0023] In addition, the sputtering system concerning this invention changes only the magnetic circuit 110 in the conventional single erosion cathode fundamentally, and does not ask for essential modification at all about the components of the cathode configuration of those other than magnetic-circuit 19. That is, about a target 17 and the back up plate 18, it shall have the same configuration as the conventional cathode. In addition, in the following explanation, although the target 17 is made into the rectangle configuration, the configuration of a target 17 is not limited with the sputtering system concerning this invention.

[0024] Below, the cathode 13 mentioned above is explained to a detail, referring to drawing 2 **** drawing 5 .

[0025] As the cathode 13 was mentioned above, the negative electrical potential difference is impressed, and vertical electric field are formed to the front face of the cathode drop. the inner magnet which has the configuration where it moved in a zigzag direction as the magnetic circuit 19 which constitutes a cathode 13 was shown in drawing 3 , and has been arranged in the center of a magnetic circuit 19 -- the outer magnet arranged so that 20 and this inner magnet 20 may be surrounded at the predetermined spacing -- it is constituted by 21 and the yoke 22. In inner magnet 20, as outer magnet 21, as shown in drawing 4 , each pars basilaris ossis occipitalis is magnetically connected with the yoke 22.
[0026] a magnetic circuit 19 -- an inner magnet -- 20 and an outer magnet -- 21 is made into the magnetic polarity of reverse at each other -- an inner magnet -- 20 and an outer magnet -- a magnetic field is formed between 21. in addition, the flux density of the magnetic field formed in a magnetic circuit 19 of a magnetic circuit 19 serves as a value equivalent to the conventional thing about the direction of a front face of a target 17 on the front face of a target 17 -- as -- an inner magnet -- 20 and outer magnet 21 are chosen. In addition, an inner magnet and an outer magnet here are good also as a permanent magnet, and good also as an electromagnet which makes adjustable the field impressed to a target 17.
[0027] The magnetic circuit 19 constituted as mentioned above forms a semicircle-like magnetic field on the front face of a target 17. As shown in drawing 2 , the line of magnetic force 23 of the shape of a semicircle produced at this time stands in a row as a configuration where it moved in a zigzag direction, and serves as tunnel-like structure. The structure of the shape of this tunnel serves as a closed contour closed by the magnetic circuit 19, moving in a zigzag direction.
[0028] The high density plasma 24 restricted by electric field and the magnetic field exists in the upper part of this line of magnetic force 23, and this high density plasma 24 stands in a row as a configuration where it moved in a zigzag direction like the structure of the shape of a tunnel of line of magnetic force 23, and serves as pipe-like structure. The structure of the shape of this pipe also serves as a closed contour closed moving in a zigzag direction.
[0029] That is, in the sputtering system concerning this invention, the secondary electron calculated from the front face of a target 17 at the time of a spatter performs cycloid motion in response to the Lorentz force under the effect of electric field and a magnetic field. Since cycloid motion of this secondary electron shows the orbit of the configuration where the structure of the shape of a tunnel of the line of magnetic force 23 which a magnetic field forms was met and where it moved in a zigzag direction, a secondary electron will draw the orbit of the closed contour closed moving in a zigzag direction, and will continue carrying out cycloid motion. For this reason, the probability for an electron to exist on this closed contour closed moving in a zigzag direction becomes high. That is, the high density plasma 24 is generated inside the structure of the shape of a tunnel of line of magnetic force 23.
[0030] The electric field by the cathode drop on target 17 front face accelerate, and the discharge gas ion which is contained in the high density plasma 24 generated inside this tunnel-like magnetic field and which was charged in plus collides with a target 17. Thereby, the spatter of the target component is carried out. Therefore, a closed contour closed moving in a zigzag direction by predetermined width of face as shown in drawing 5 is served as to a target 17, the field 25, i.e., the erosion field, where plus ion collides.
[0031] As for this erosion field 25, the bay 101 is almost eliminated and the curvilinear section consists of two or more curves of the value with the almost same curvature so that clearly from drawing 5 . Therefore, in 13 of the cathode which forms the configuration of such an erosion field 25, as compared with the single erosion cathode in conventional SUPPATTA ring equipment, since a bay is hardly intermingled in the curvilinear section of the erosion field 25, and it is the value with high and spatter effectiveness and the almost same curvature of the curvilinear section, it is possible to acquire homogeneous high spatter effectiveness. Furthermore in a cathode 13, an erosion field can lengthen the circumference of

a rear spring supporter and this erosion field about 1.7 times all over a target as compared with the conventional single erosion cathode. Therefore, spatter effectiveness is raised and a deployment of a target can be performed.

[0032] In addition, although it enables it to consider that the erosion field 25 which appears in the front face of a target 17 at the time of a spatter by incorporating the magnetic circuit 19 which has the configuration where it moved in a zigzag direction in a cathode 13 is one closed closed contour in the example mentioned above, moving in a zigzag direction, the cathode with which the same effectiveness is acquired is also possible.

[0033] the inner magnet made into the configuration where it moved in a zigzag direction linearly, and the so-called zigzag configuration as a magnetic circuit 19 was shown in drawing 6 in a cathode 13 -- the outer magnet arranged at predetermined spacing around 61 and this inner magnet 61 -- it is good though it has 62. moreover, the inner magnet which carried out the configuration of a comb mold which shows a magnetic circuit 19 in drawing 7 -- the outer magnet arranged at the predetermined spacing around 71 and this inner magnet 71 -- it is good though it has 72. Thereby, the same effectiveness as **** can be acquired.

[0034] Furthermore, the sputtering system concerning this invention is equipped with the magnetic-circuit actuator (not shown) which drives the magnetic circuit 19 mentioned above, and is good for the direction of an arrow head G thru/or an arrow head H also as migration being free to the target 81 shown by the two-dot chain line in drawing 8 by this magnetic-circuit actuator. In this case, it is possible by performing a spatter to equalize the amount of erosion further on the target 81 whole surface, moving a magnetic circuit 19 to a target 81 by the magnetic-circuit actuator.

[0035] Moreover, two or more magnetic circuits 19 by this invention may be arranged at the same target rear face for the purpose of raising a sputtering rate the same with having changed to the double erosion cathode from the single erosion cathode used from the former. Thereby, it becomes possible to raise a sputtering rate substantially.

[0036]

[Effect of the Invention] It is made for the sputtering system concerning this research to serve as a closed contour closed moving the erosion field which appears in a target front face in a zigzag direction by devising arrangement of the magnetic circuit in a target rear face, as explained above.

[0037] Thereby, the bias of the curvature of the erosion field of the whole target surface can be canceled, and the total extension of the closed contour showing the erosion field which appears in a target front face can be lengthened by lengthening the die length of the locus to which the secondary electron emitted from a target can carry out cycloid motion as much as possible. Therefore, while being able to raise a sputtering rate substantially, unevenness is made as for ****** to the thickness of a thin film few. Moreover, since spatter effectiveness high on the average is acquired over the whole target surface, the improvement of a target life to the amount of membrane formation to a substrate is also expectable.

Claim(s)]

[Claim 1] It is the sputtering system characterized by to be arranged so that it may become the closed contour which closed the erosion field where the above-mentioned magnetic circuit appears in the front face of the above-mentioned target in the sputtering system which is equipped with the back up plate which is connected to a power source and has a function as a cathode electrode, the target adhered to this back-up-plate front face, and the magnetic circuit which counters the above-mentioned target and is arranged at the above-mentioned back-up-plate rear face, and performs sputtering to spatter-ed material lying in a zigzag line.

[Claim 2] The above-mentioned target is a sputtering system according to claim 1 characterized by considering as the rectangle configuration.

[Claim 3] The above-mentioned magnetic circuit is a sputtering system according to claim 1 characterized by being arranged so that the curvature of the above-mentioned erosion field may not have a bias on the whole surface of the above-mentioned target.

[Claim 4] The above-mentioned magnetic circuit is a sputtering system according to claim 1 characterized by arranging the curvature of the orbit by cycloid motion of the secondary electron emitted from the above-mentioned target front face at the time of a spatter so that there may be no bias on the whole surface of the above-mentioned target.

[Claim 5] The sputtering system according to claim 1 characterized by having two or more above-mentioned magnetic circuits.

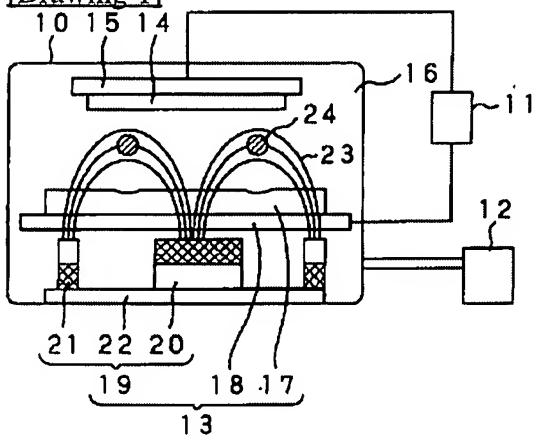
[Claim 6] The sputtering system according to claim 1 characterized by having the magnetic-circuit actuator which enables migration of the above-mentioned magnetic circuit to the above-mentioned target.

* NOTICES *

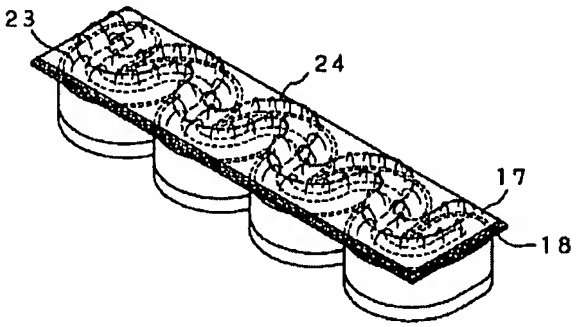
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

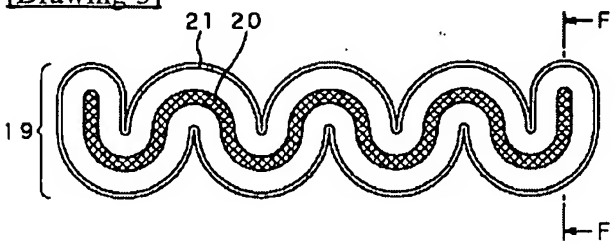
[Drawing 1]



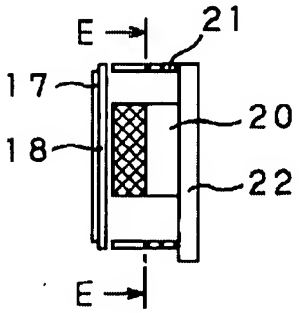
[Drawing 2]



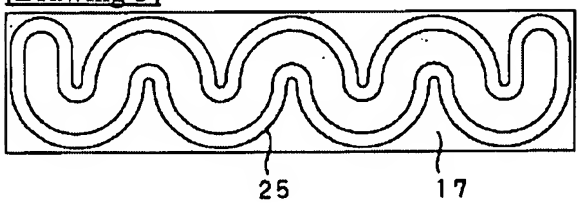
[Drawing 3]



[Drawing 4]



[Drawing 5]



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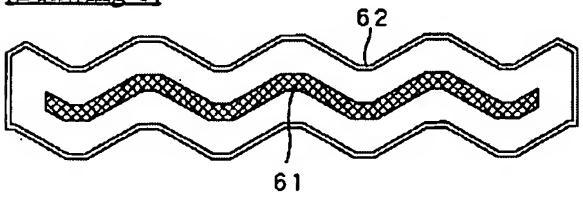

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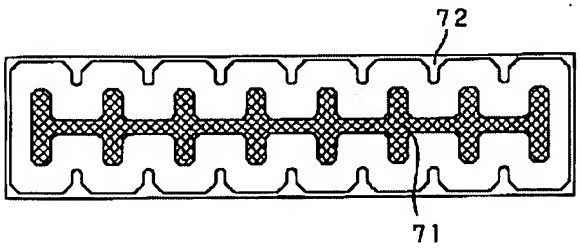
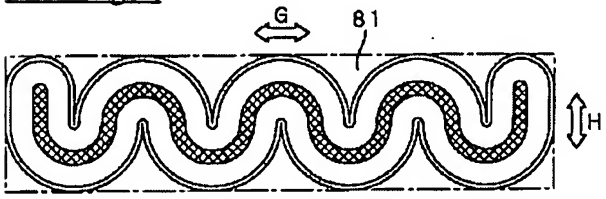
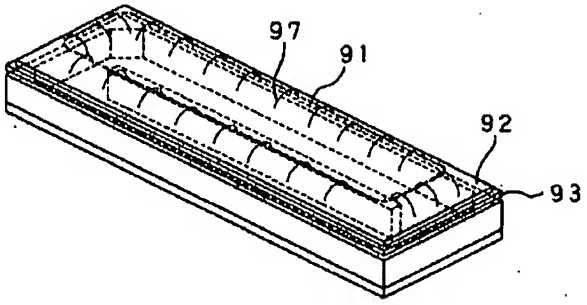


[Drawing 8]



[Drawing 9]



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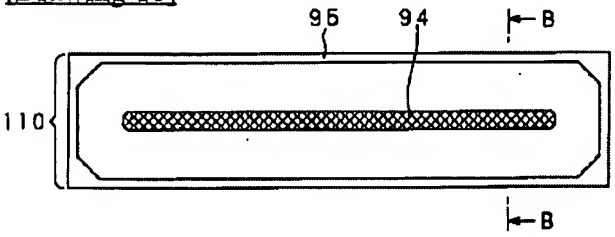

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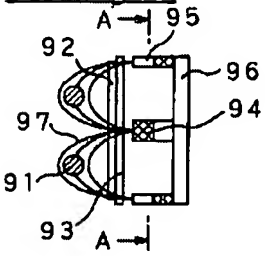
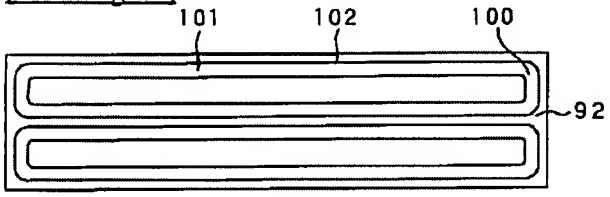
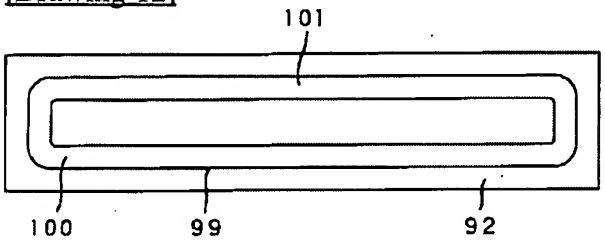


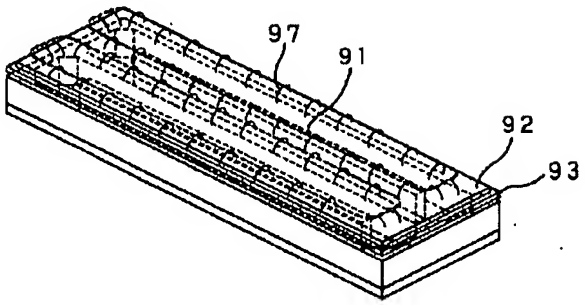
[Drawing 16]



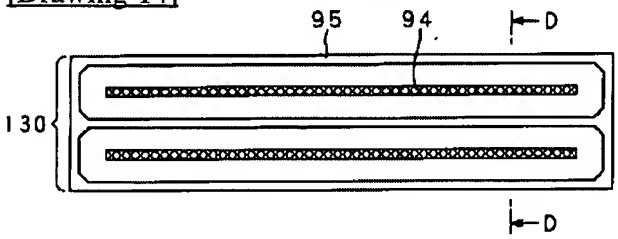
[Drawing 12]



[Drawing 13]



[Drawing 14]



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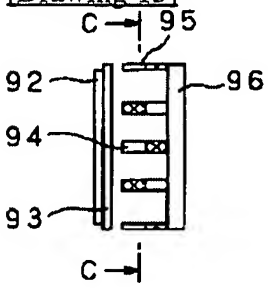

[Translation done.]